

**MEDIA TEK**

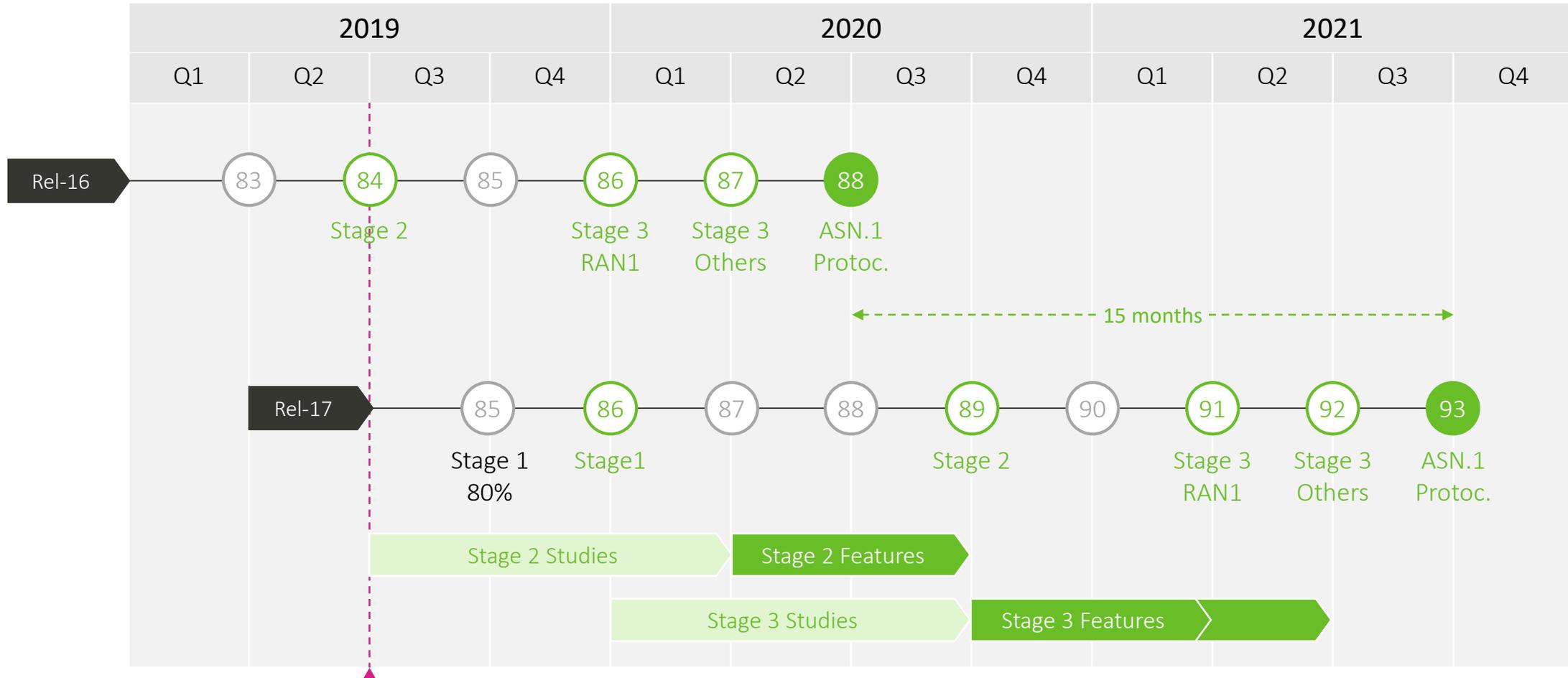
# MediaTek view on Release 17 RAN

3GPP TSG RAN#84  
Newport Beach, CA, USA  
June 3-6, 2019  
A.I. 8

**MediaTek Inc.**

# Release 17 timeline

## 15-month release



# Unleash wireless – everyone, everything, everywhere



## New Mobile Experiences

Main drivers  
eMBB, URLLC

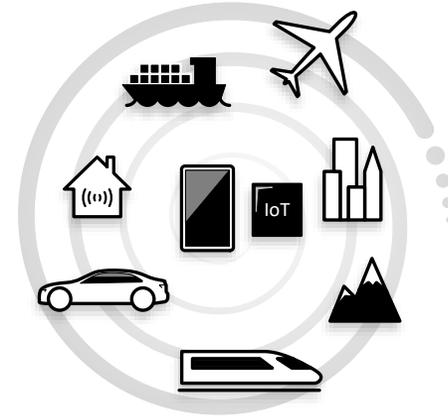
Critical enablers  
Consistent UX, Energy efficiency



## Industries Transformation

Main drivers  
mMTC, URLLC, V2X<sup>1</sup>

Critical enablers  
Reachability, Energy efficiency



## Ubiquitous Connectivity

Main drivers  
eMBB, mMTC, URLLC

Critical enablers  
Technology, Spectrum

NOTE 1: V2X enablers defined pre-Rel-17

# Rel-17 in a nutshell

## Main directions

- Energy efficiency
  - Power consumption reduction in mmW and unlic. spectrum
  - Power consumption reduction with/without data Rx/Tx
  - Power consumption reduction of 5G technology components
- Consistent user experience / reachability
  - Higher-layer protocol enhancements
  - Cell-edge coverage enhancements e.g. CoMP
  - UE-assisted interference mitigation
- Ubiquitous connectivity
  - UE-based 'indoor' coverage
  - Support for NTN with NR
  - Support for NTN with NB-IoT
- (I)IoT
  - NR IoT (power and data efficiency)
  - More potent NB-IoT (mobility, latency, data rate)
  - Further URLLC enhancements (cell edge, spectrum & energy efficiency)
- New NR bands and associated enablers

# Key Priorities

## NR, NB-IoT

Efficiency / New mobile experiences		IoT – Industries Transformation		Ubiquitous Connectivity	
UE Power Saving Enhancements <a href="#">RP-191096</a> <ul style="list-style-type: none"> <li>FR2 UE battery drain</li> <li>Idle/Inactive (Option 2)</li> </ul>	HIGH	NR-IoT <a href="#">RP-191103</a> <ul style="list-style-type: none"> <li>Enable new IoT business for NR</li> <li>Incl. power saving, capability combo</li> </ul>	HIGH	NR Coverage Enhancement <a href="#">RP-191097</a> <ul style="list-style-type: none"> <li>Resolve eMBB indoor coverage problem</li> <li>Incl. sidelink-based UE relay</li> </ul>	HIGH
Enh. for Higher Layer Protocols <a href="#">RP-191106</a> <ul style="list-style-type: none"> <li>Improve FR2 user throughput</li> <li>Incl. ACK optimisation, Link switch</li> </ul>	HIGH	eNB-IoT <a href="#">RP-191104</a> <ul style="list-style-type: none"> <li>Migrate GSM IoT to NB-IoT</li> <li>16QAM<sup>1</sup>, Latency reduction, NTN</li> </ul>	HIGH	NTN NR <a href="#">RP-191105</a> <ul style="list-style-type: none"> <li>Truly ubiquitous connectivity</li> <li>Smartphone form factor</li> </ul>	HIGH
UE-based interference mitigation <a href="#">RP-191098</a> <ul style="list-style-type: none"> <li>Address flashlight interference effect due to massive MIMO</li> </ul>	HIGH			NTN NB-IoT	

NOTE 1: Rel-16 preferred to address urgent market demand

Spectrum	Technology	Regulatory
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# Secondary Priorities

## NR

Efficiency / New mobile experiences		IoT – Industries Transformation		Ubiquitous Connectivity	
		IIoT/URLLC <a href="#">RP-191102</a> <ul style="list-style-type: none"> <li>Improve system capacity, spectral efficiency</li> <li>Reduction UE processing time</li> <li>Unlicensed spectrum operation</li> </ul>	MID		
Spectrum		Technology		Regulatory	
>52.6GHz (R17 study)	<a href="#">RP-191101</a>	MID	Multi-SIM <ul style="list-style-type: none"> <li>Continuation to SA2 study</li> </ul>	MID	Public safety (w/ generic NR SL) NEUTRAL
Unlicensed 60GHz		NEUTRAL	B/M Cast	NEUTRAL	
			Positioning incl. indoor	NEUTRAL	

# UE Power Saving Enhancements

Lead: RAN1

*Secure 5G/NR success*

See [RP-191096](#)

## Motivations

- User experience is key to 5G/NR success – battery life is critical for battery-powered devices and small form factor devices
  - Today sets the expectation: battery life must improve for 4G-like applications and must be at least as good with 5G applications
- Significant improvements in Rel-16 i.e. connected mode and Sub-6
- Significant improvements necessary in Rel-17
  - Idle/inactive (NR SA), FR2, NR-U
- URLLC power efficiency for non-IIoT battery-powered devices

## Objectives

- Power model + evaluations to include Idle & Inactive, FR2, NR-U, URLLC
- Idle & Inactive enhancements
  - Wake-up design for (beam-formed) paging
  - eDRX supported for NR
  - Assistance information broadcast to idle/inactive mode UEs
- FR-2 specific enhancements
  - More aggressive PDCCH monitoring reduction during data inactivity
  - Power saving for beam-management
- NR-U enhancements
  - Identify potential gaps and potential additional enhancements to minimize UE Rx activity (depending on Rel-16 outcome)
- Control channel enhancements for URLLC UEs to minimize UE Rx activity

# NR Coverage Enhancements

Lead: RAN1

*Expand operators footprint at minimum costs*

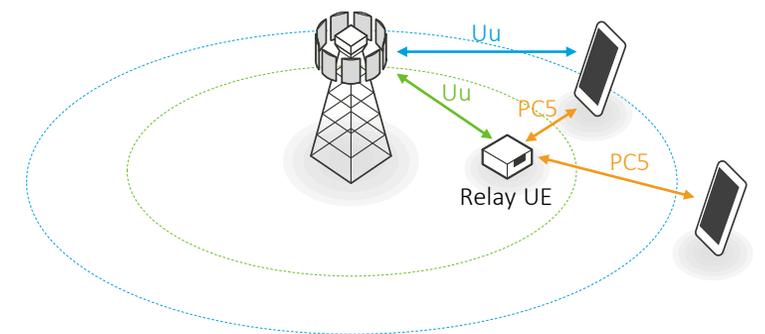
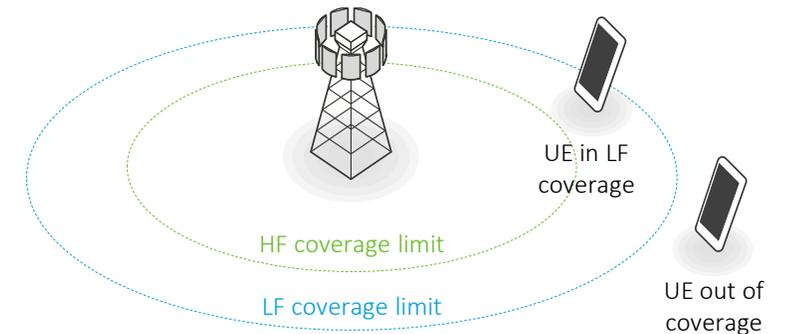
See [RP-191097](#)

## Motivations

- Most NR spectrum in C-band (3-6GHz) and FR2
  - Very limited additional capacity in low bands (0.6-2GHz) relative to LTE – data rate cap
    - Only low bands deliver deep indoor coverage
  - Lower/No indoor penetration in C band (3-6GHz) and mmW spectrum
  - Deep indoor coverage in higher bands necessary to deliver 5G experience
- ⇒ UE-based approaches to enable NR data rates indoors in suburban/rural areas
- ⇒ Seamless “out-of-the-box” operation with no/limited user intervention

## Objectives

- Deployment scenarios incl. both licensed and unlicensed spectrum ( $\leq 52.6$ GHz)
- Study and evaluation of PHY sidelink enhancements [RAN1]
- Study relay architecture using Sidelink [RAN2]
- Consider misc. relaying scenarios e.g. CP/UP split [RAN2/3]
- Specify low-hanging fruits in Rel-17 (leave further evo in Rel-18 e.g. Multihop, group mobility, unlicensed sidelink)
  - Usable solution should be available ASAP



# UE-based interference mitigation

Lead: RAN1

*Address flashlight-like and cross-link interference for better user throughput*

See [RP-191098](#)

## Motivations

- Rel-15 NR highly directional Tx with massive MIMO causes flashlight-like intra/inter-cell interference
  - Interference level varies rapidly due to fast beam/precoder change across cells
  - Very difficult to track such interference by CSI acquisition due to long round-trip delay
- Rel-15 NR dynamic TDD causes cross-link inter-cell interference
  - Interference level varies rapidly due to fast Tx direction change across cells
  - Very difficult to track such interference by CSI acquisition or RRM measurement/report due to long round-trip delay

## Objectives

- Identify the advanced receiver types for interference mitigation in the following use cases
  - Intra-cell interference due to MU-MIMO
  - Inter-cell interference with same transmission directions
  - Inter-cell interference with different transmission directions
- Identify network assistance information for a receiver to efficiently cancel or suppress the interference with the identified advanced receiver types
- Specify a new DCI format to carry the network assistance information

# NR-based NTN

## Lead: RAN1

*Truly ubiquitous mobile broadband*

See [RP-191105](#)

### Motivations

- Non-covered areas e.g. rural broadband, maritime and aircraft communications
- NR suitability for satellite spectrum
- New market opportunities
- LEO deployments can enable NTN service with same cellular device form factor and antenna design
  - Typical LEO Satellite RTT compatible with many Real Time applications
  - Typical LEO Link budget compatible with NR cell-edge data rates

### Objectives

- System information, paging, TA [RAN2]
- Mobility enhancements [RAN2, RAN1]
  - Idle mode beamspot / cell re-selection
  - Connected mode HO
- Initial Access [RAN1, RAN2]
  - Timing advance acquisition and update
  - New RACH preamble format, 4-step RACH
- More delay tolerant transmissions [RAN1, RAN2]
  - UL transmission timing solution to accommodate satellite RTT
  - Re-transmissions at one or several layers if HARQ disabled, HARQ optimization w.r.t. number of HARQ processes and soft buffer size if HARQ enabled
- Physical layer control procedures [RAN1, RAN2]
  - UL power control, AMC, Doppler shift compensation
- RRM/RF performance requirements [RAN4]

# NB-IoT-based NTN

Lead: RAN1

*Unleash significant market opportunities with minimal changes*

See [RP-191105](#)

## Motivations

- Minimal impact to NB-IoT specs. can unleash significant new market opportunities
- Truly ubiquitous coverage
  - Non-covered areas e.g. rural broadband, maritime routes
- Transportation and logistics
- No need to disable HARQ
  - Legacy HARQ scheduling delay KO can accommodate delay
  - Latency is not an issue for delay-tolerant IoT applications
- Simpler operations in NB-IoT
  - No HO in connected mode
  - No CSI measurements – UE re-selects new cell when RLF is triggered

## Objectives

- System information, paging, TAU [RAN2]
- Mobility [RAN2, RAN4]
  - Idle mode beamspot / cell re-selection
- Initial access [RAN1/RAN2]
  - Timing advance acquisition and update
  - New RACH preamble format
  - 4-step RACH
- RRM/RF performance requirements [RAN4]

# Further enhancements to URLLC

Lead: RAN1

*URLLC with better efficiency*

See [RP-191102](#)

## Motivations

- NR-U URLLC: URLLC in unlicensed spectrum is challenging, but a subset of URLLC requirements may be satisfied.
- Balancing UE complexity with URLLC requirements: Traffic pattern for most stringent latency is highly predictable, and does not need the same scheduling flexibility as for eMBB traffic. Unnecessary flexibility causes poorer spectral efficiency and also unnecessary UE complexity.
- Capacity: More attention required on URLLC spectral efficiency and overall system capacity.

## Objectives

- Extending NR-U specification to support at least some URLLC services.
- Introducing a trade-off between UE critical processing time requirements (N1, N2, etc.) and URLLC traffic predictability.
- Performance and spectral efficiency enhancements (e.g. UL transmit diversity, CSI enhancements).
- De-prioritised R16 topics: Mobility capability for URLLC.

# Higher-layer protocol enhancements

Lead: RAN2

Fully exploit NR data rates in FR1 and FR2

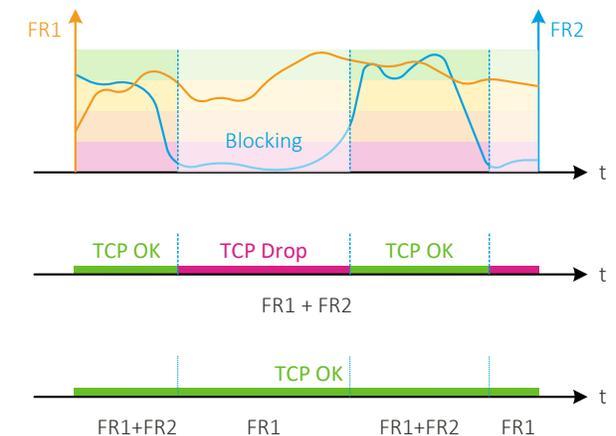
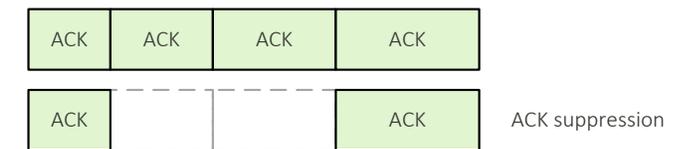
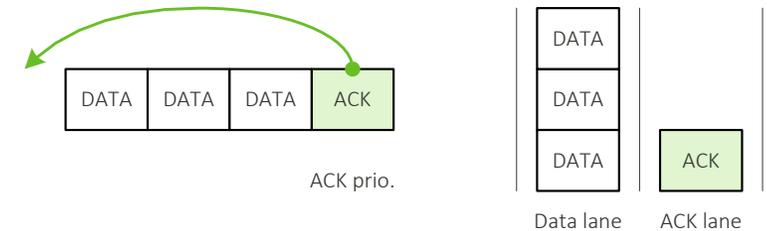
See [RP-191106](#)

## Motivations

- TCP: pre-eminent transport protocol with known performance bottlenecks
- TCP Acknowledgements
  - Intermingling with TCP Data: head-of-line blocking resulting in lower Tput
  - Cumulative: High ACK volume with redundant ACKs
- TCP high-sensitivity to connection loss esp. with FR2
  - Exacerbated with mmW blocking (buildings, vehicles, human movements, etc.)
- TCP performance in DC constrained by the slower link
- Sudden data rate drop (e.g. Inter RAT HO NR to LTE) results in huge packet buffering and sudden increase in RTT leading to unnecessary TCP congestion control and reTx.
- Commonalities with other protocols/enhancements (e.g. QUIC, TCP BBR)

## Objectives

- Common system model, scenarios and metrics for evaluation
- Quantitative evaluation of RAN enhancements followed by down-selection
- Impact on RAN2 specifications incl. UP/CP aspects



# NR IoT

## Lead: RAN2

### *Power efficient broadband IoT*

See [RP-191103](#)

#### Motivations

- Battery Powered embedded devices that can also support medium/high data rates.
- Power consumption remains a critical enabler for IoT
- Unique IoT opportunities stem from NR-U
- Need to balance data rates, latency and power consumption, especially standby power consumption
- Coverage critical for b2b cases. Enhancements to coverage, e.g. indoor coverage, to take into account IoT cases

#### Objectives

- Idle mode / RRC Inactive power saving
  - NR support for eDRX
  - NR enhanced wakeup handling for Idle and Inactive modes.
- Background traffic / Signaling enhancements
  - EDT for UEs in RRC Inactive mode with 2-step RACH and 4-step RACH.
- Scalable UE capability combinations
  - UE Cat 100-200 Mbps

# eNB-IoT

## Lead: RAN2

*Expand NB-IoT footprint where market demands*

See [RP-191104](#)

### Motivations

- Clear demand for a more capable NB-IoT driven by affordability. NB-IoT not to have worse performance than GSM GPRS for IoT cases.
- Connected mode mobility service interruption is significant for applications with longer time in connected mode, e.g. Kids watch, short cycle tracker, at file downloads.
- Latency is important for interactive embedded applications, e.g. Sales/Payment terminal.
- Spectrum efficiency and data rates not near state of the art. Enhancement opportunity without significant cost impact

### Objectives

- Data rates and efficiency enhancements in both UL and DL: higher order modulation [RAN1]
- Latency enhancements: carrier “segregation” per coverage level [RAN2]
- Mobility enhancements: Measurement triggered mobility in connected mode [RAN2]

# Misc. NR improvements

- “Normal” technology-driven evolution
  - E.g. Gaps in earlier releases, issues arising in initial deployments
- Further MediaTek views towards RAN#84
  - E.g. UL MIMO codebook design
- See [RP-191099](#) (NR MIMO), [RP-191100](#) (NR-U)

# Thank You!